Groundwater, Agriculture and Forestry Indicators

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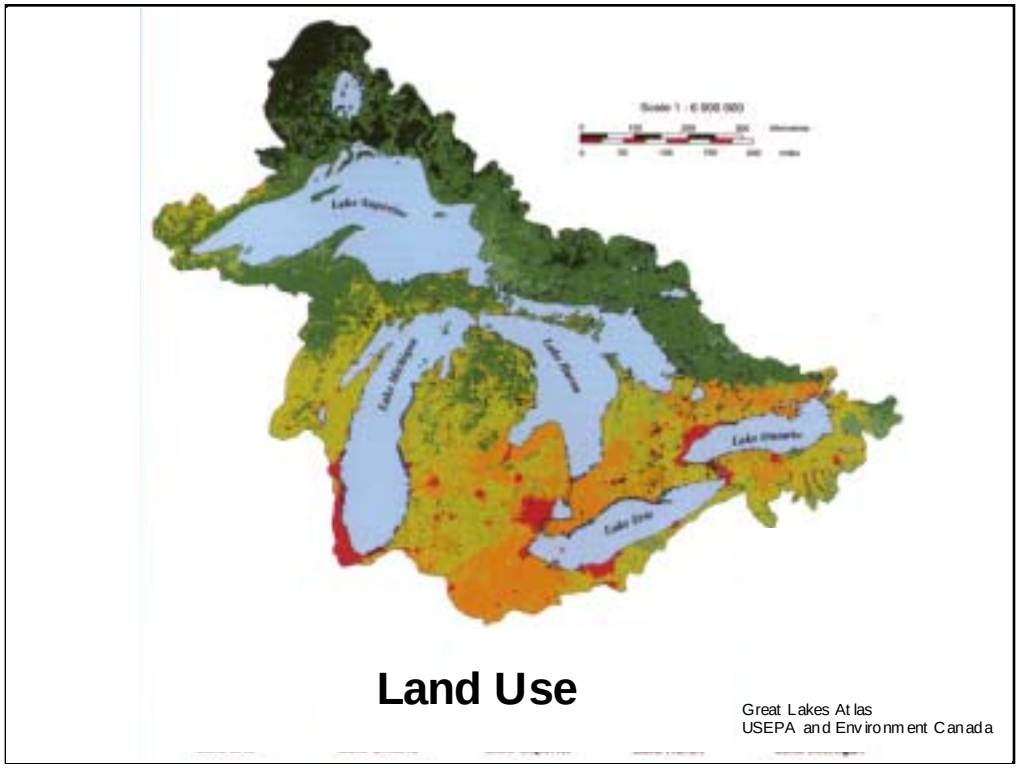
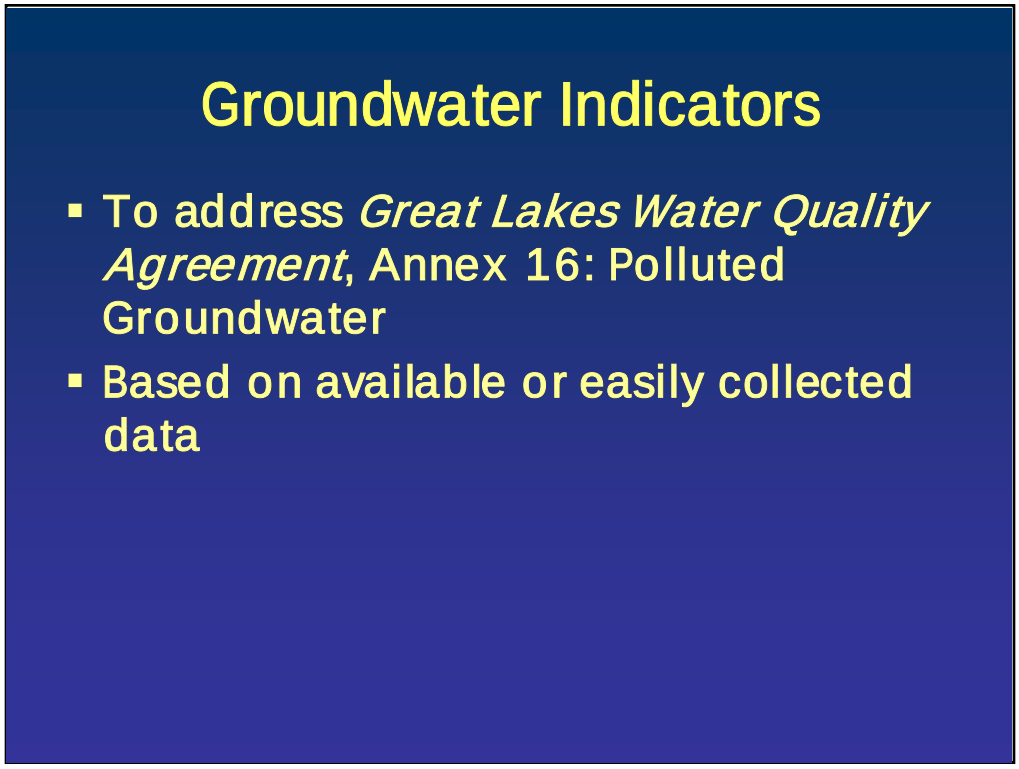
Good morning, my name is Norman Grannemann and I am here to present three categories of proposed indicators. They are groundwater, agriculture and forestry.

I have worked on groundwater resource issues as a hydro geologist for the U.S. Geological Survey in the Great Lakes Region since 1977 and I am glad to see that groundwater is being recognized as an important part of the water budget in the Region. It is easy to overlook groundwater because it is not visible to us. We see many images of the Great Lakes, inland lakes, and streams, but it is hard to visualize groundwater, and even harder to understand the important role it plays in the Great Lakes region. The groundwater system in the Great Lakes Watershed has been estimated to store approximately as much water as is stored in Lake Michigan. The interaction of groundwater with surface water in the region is vital to understanding water resources in the Great Lakes.



Land-use patterns in the Great Lakes Basin are a good way to illustrate the need for agricultural and forest indicators. These patterns are largely dictated by soil type, and climate. For example the north is dominated by forests growing on poorer soils in cooler parts of the basin.

In the south, the soils and climate are more suitable for agriculture (and human habitation), hence the dominance of agriculture in the south.



I would like to begin by addressing the Groundwater Indicators. These indicators are meant to address Annex 16 of the Great Lakes Water Quality Agreement. We have selected indicators for which data are available or which can be easily collected. The illustrations that I will show are just that, illustrations. They are not meant to be exhaustive reports on that particular indicator.

Although Annex 16 emphasizes water quality, groundwater indicators are designed to evaluate the status and trends of groundwater resources related to both availability of groundwater and quality of groundwater since these two aspects of groundwater are integrally related.

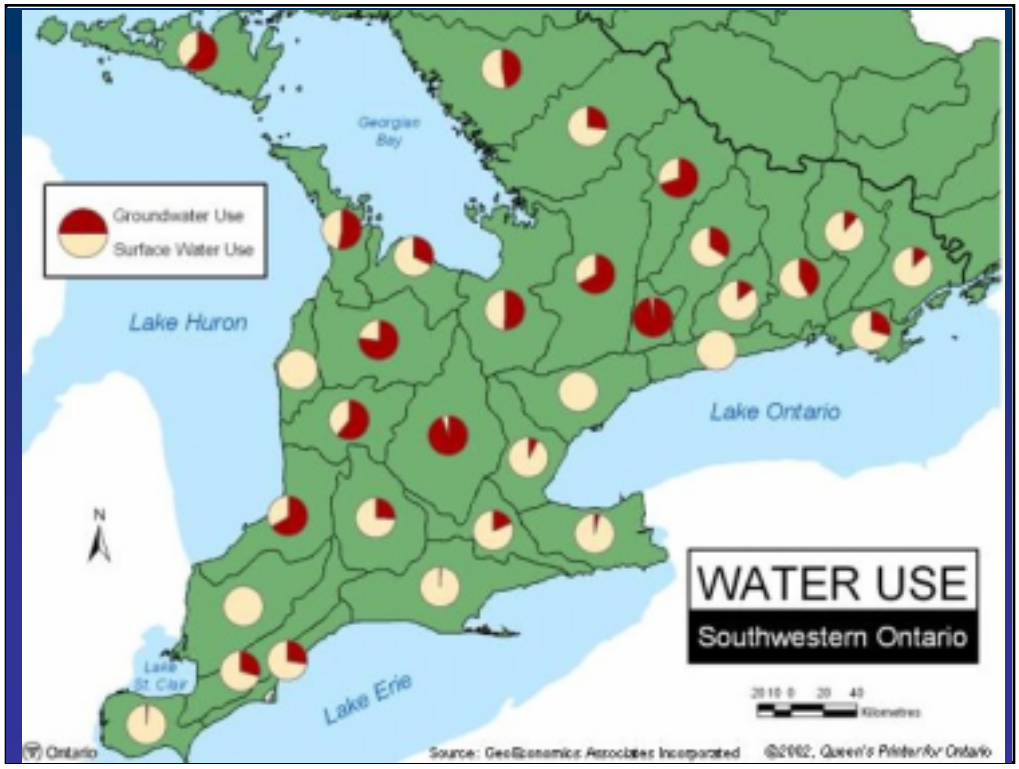
We have proposed 7 indicators of groundwater quality and quantity. They were compiled or written by a group of volunteers, some of whom will be in the groundwater breakout session that begins at 12:45 in Room 205A this afternoon. The indicator titles shown in YELLOW are those for which we have some examples to show this morning. We plan to have reports on all 7 proposed indicators for SOLEC 2004, if they are adopted through the SOLEC process.

These indicators have a range of information about how much groundwater we use to meet human and ecosystem needs as well as how much groundwater discharges to streams, the changes in groundwater quality due to natural and human causes, the relations between land use and groundwater quantity and quality, and information about how we manage groundwater resources.

Water Use

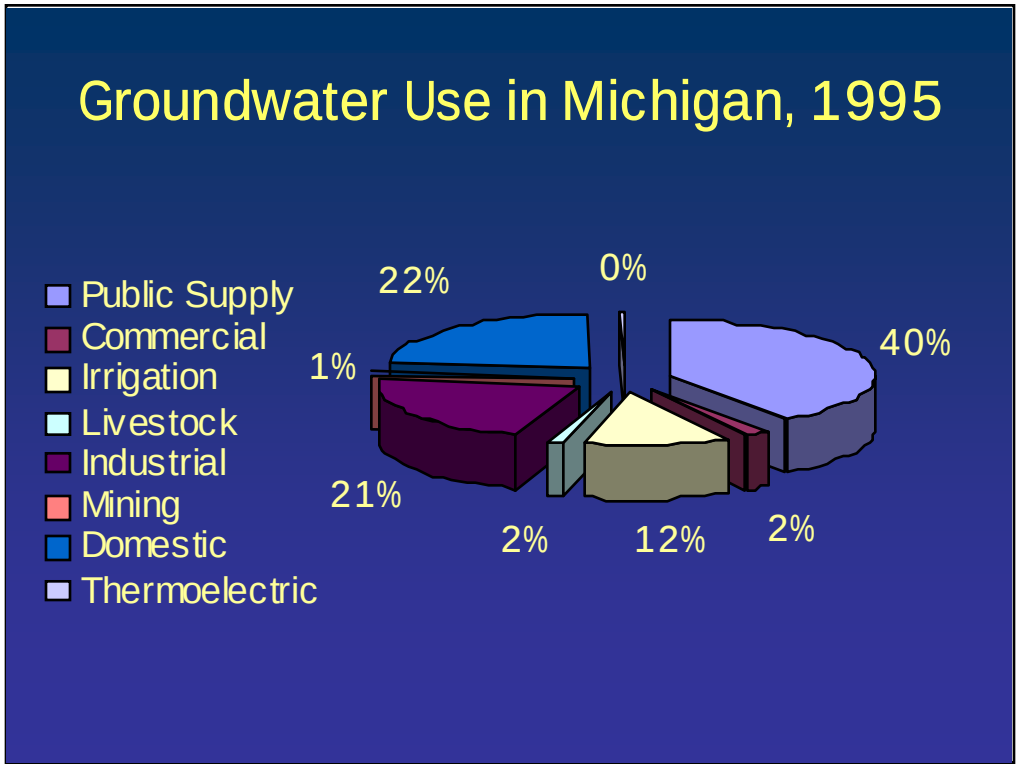
- Measures water use within political sub-divisions;
- Infer the potential impacts of use and intensity on quantity and quality of groundwater.
- Also measures supply versus demand by assessing the construction of new wells or deepening of existing wells.

Water use is the aspect of water resources that is most closely associated with human activities. Knowing how much and at what rate groundwater is pumped for various purposes is integral to understanding the impact of that pumping on the groundwater system. If the hydraulic properties of the groundwater system restrict the movement of groundwater, the impact of a withdrawal will be greater. In addition, the quality of groundwater is more likely to be degraded as the rate and amount of withdrawal increases. The number and depth of new and replacement wells is proposed as one indicator of the stress on an aquifer due to increased water use.

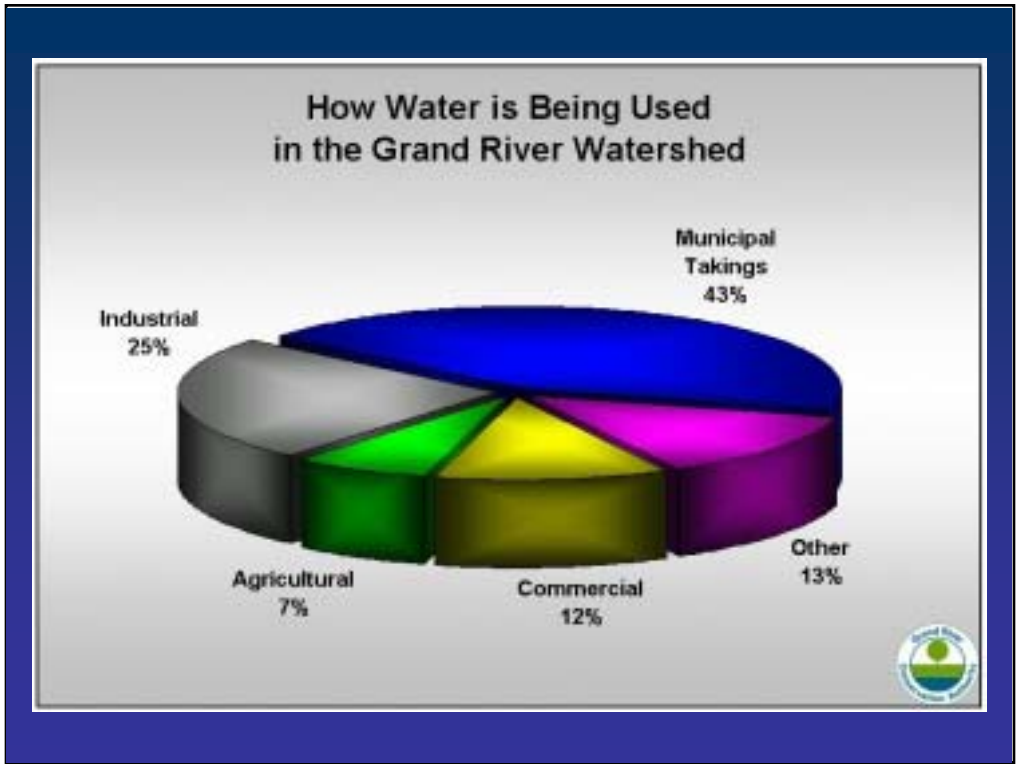


Most large public water supplies in the Great Lakes Region are obtained from the lakes themselves but groundwater is the source of water for at least 8 million people in the watershed. Communities located near the shore of one of the Great Lakes or the connecting channels most often utilize surface water for supply, whereas, those communities further inland more often rely on groundwater as illustrated in this map of Southwestern Ontario.

This graphic shows estimated ground-water withdrawal rates for some major U.S. metropolitan areas. Even metropolitan areas that mostly rely on surface water may also have large groundwater withdrawals—for example, Chicago and Detroit.



It is instructive to break down the types of use for groundwater into its component parts. This slide shows various uses of groundwater in Michigan for 1995 (the most recent nationally published data). New data for 2000 will be available in the near future. As you can see from the pie chart, about 40 percent of the groundwater pumped in Michigan is for public supply; 22 percent for domestic supply (individual wells), 21 percent for industrial use, and 12 percent for irrigation. This accounts for 92 percent of the 858 million gallons per day pumped in Michigan. For the U.S. portion of the Great Lakes Watershed, total groundwater pumped was about **1,500 million** gallons per day. For comparison, total surface water withdrawals in the Great Lakes Basin, excluding water for thermoelectric cooling, was about **8,000 million** gallons per day or between **5 and 6 times** the amount of groundwater withdrawal.



This graphic shows comparable information for the Grand River Watershed in Ontario. The percentage used for each category is similar to those in Michigan.

Natural and Human-Induced Groundwater Quality

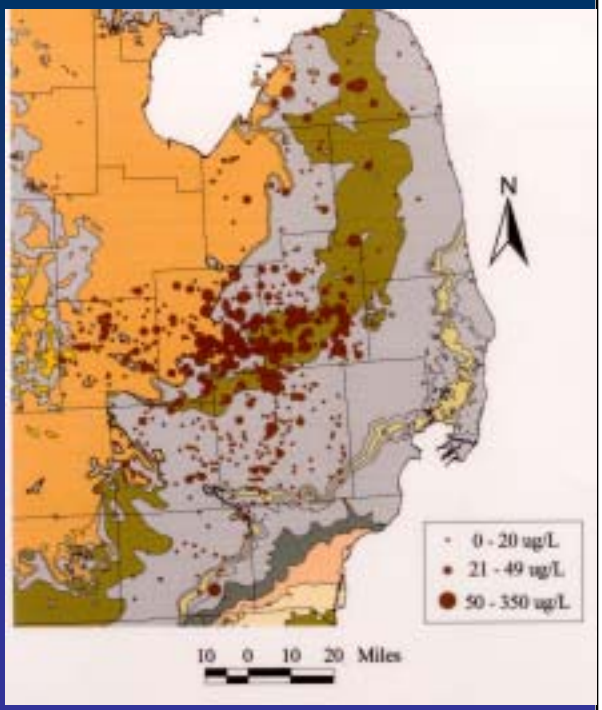
- Quality of groundwater
  - Drinking water
  - Agricultural purposes
  - Ecosystem functions
- Areas of contamination
  - Remediation, prevention of non-point contamination

The next indicator I will discuss is groundwater quality as influenced by natural and human activity.

This indicator provides information on organic and inorganic contamination as they affect human uses and ecosystem functions.

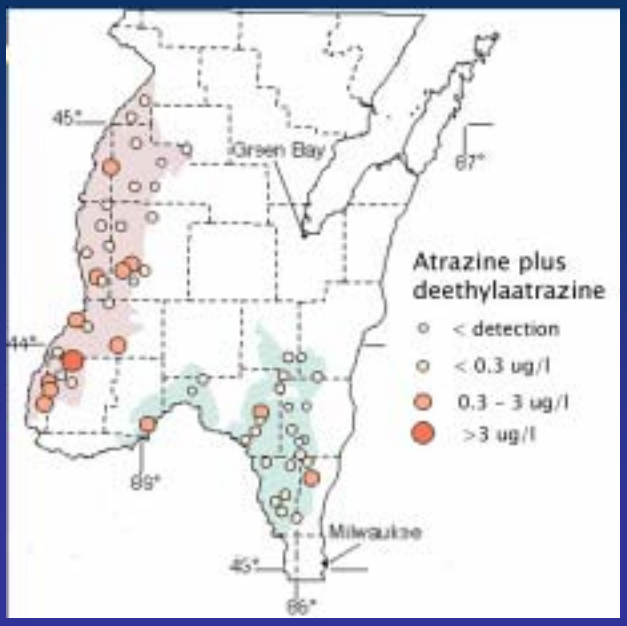
Degradation of water quality influences the uses of water for many purposes- most notably drinking water.

Arsenic in Groundwater from Southeastern Michigan



Naturally occurring arsenic in groundwater is an important concern in some parts of the Great Lakes Watershed as indicated by the information shown on this slide for southeastern Michigan. High concentrations of arsenic are only known to naturally occur in a few areas throughout the Great Lakes.

Atrazine in Groundwater from Eastern Wisconsin



This map shows atrazine concentrations in groundwater from the Lake Michigan drainage area of Wisconsin. Atrazine is a common agricultural chemical that is an example of a water-quality concern related to human activity.

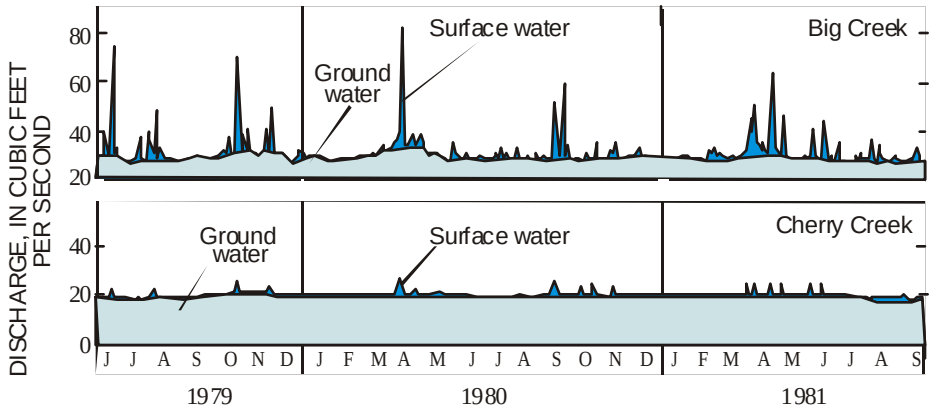
Base flow

- Contribution of groundwater to total stream flow
- Detects the impacts of humans

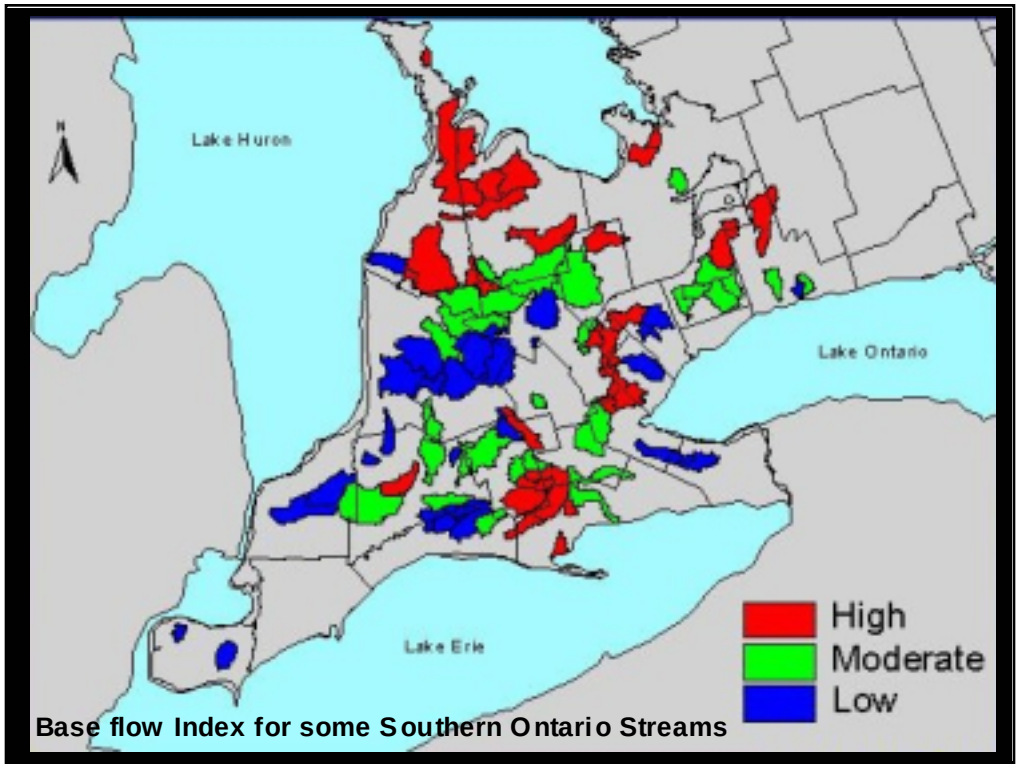
Base flow is the portion of stream flow that is not attributed to direct runoff from precipitation or melting snow. It is usually derived from groundwater inflows in most natural hydrologic settings in the Great Lakes Region. Changes in base flow may be used to help understand the impact of human activities on the groundwater system at the watershed scale.

This indicator responds to IJC Indicators Implementation Task Force recommendations on use of base flow

Examples of Base Flow

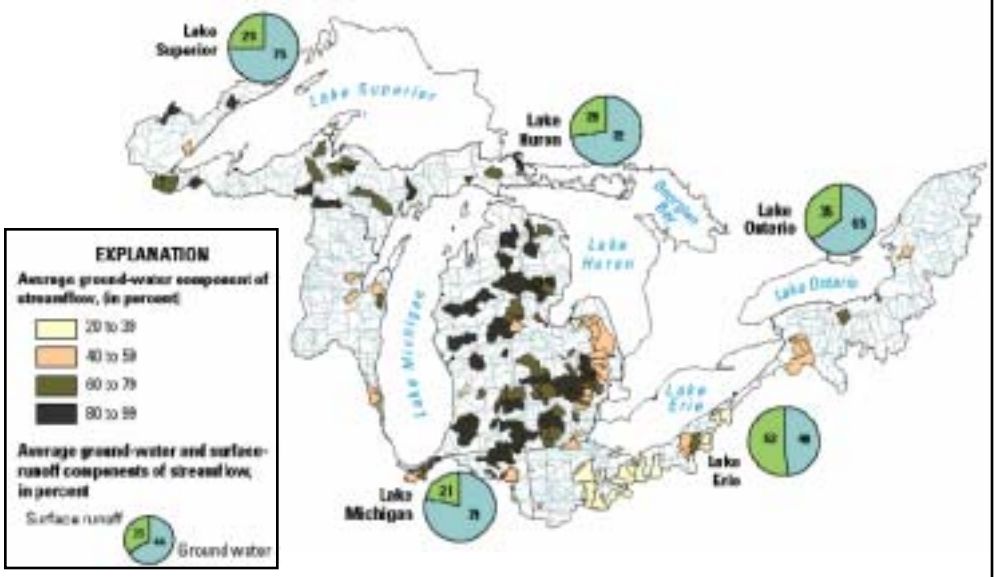


This slide illustrates base flow from groundwater discharge to two small streams that are within 2 or 3 miles of each other in the Lake Superior Watershed. Note the differences in stream discharge in response to the same precipitation events. The higher peak flows for Big Creek indicate a larger component of surface runoff than for Cherry Creek whose flow consists almost entirely of groundwater discharging to the stream.



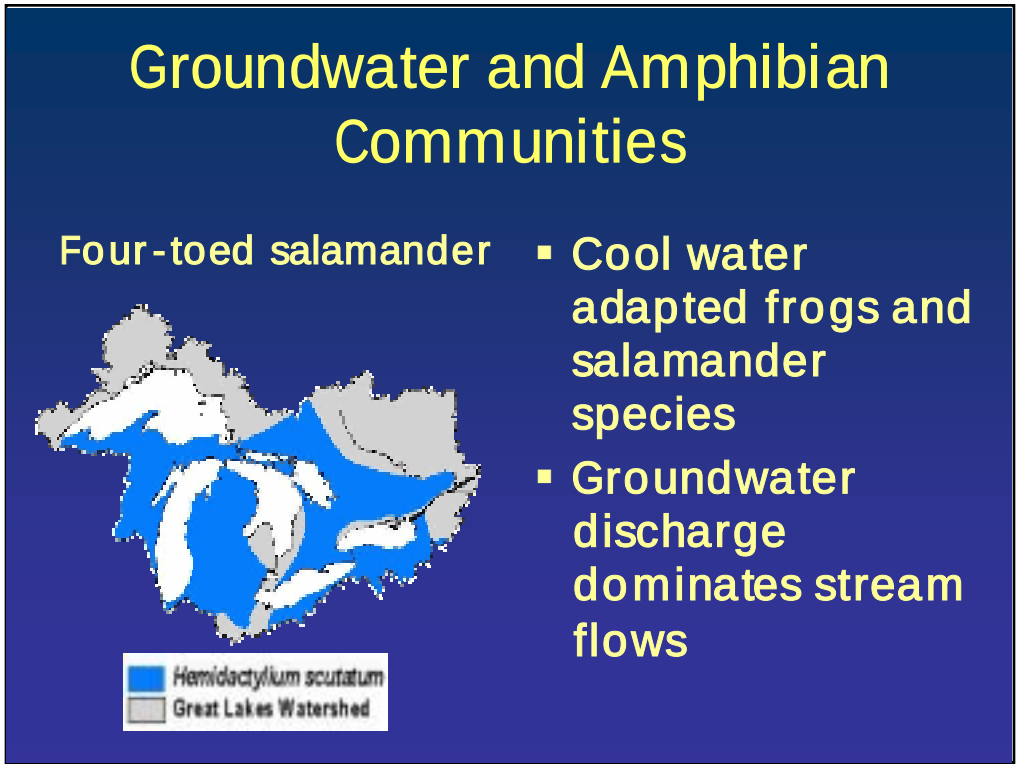
This map shows base flow for several Southern Ontario watersheds, and indicates that in some, the contribution to total flow from base flow is high (the red areas).

Base flow component of stream flow



This map shows the comparable story for the US side. The average base flow component of stream flow ranges from around 50% for Lake Erie, to around 80% for Lake Michigan.

The higher base flow component of total streamflow for streams tributary to Lake Michigan is consistent with the fact that soils and glacial deposits near Lake Michigan consist of larger amounts of sand and gravel which promotes infiltration to the groundwater system instead of running off on the surface.



A good indicator of groundwater quality and supply is a biological one, namely the amphibian community living in streams. They are very sensitive to water temperature and can be found in areas of streams with cool summer groundwater discharge.

There is good distribution for this indicator species in most of the basin. It is also a good way to relate groundwater resources to ecosystem concerns. We will be getting data for this indicator to report at the next SOLEC meeting.

Groundwater Dependant Plant and Animal Communities

- Assesses locations of groundwater intrusions
- Measures contribution of groundwater to stream and near shore flows
- Evaluates trophic status, food web dynamics, location of fish, wildlife, plant communities at risk

Brook Trout

This indicator will provide information on the distribution of plants and animals in relation to groundwater quality and quantity. It also describes certain chemical and physical parameters of groundwater, including changes in patterns of seasonal flow.

Groundwater inflow to streams is important for maintaining habitat for some fish species. This inflow helps maintain cool water temperature in the summer and relatively warm stream temperature in the winter. For example, in Wilmot Creek, just east of Toronto, stream reaches with a high groundwater component of total flow have greatest likelihood of having brook trout. During the groundwater breakout session this afternoon, we will display a map showing the stream reaches where more trout have been captured and the relation of trout habitat to groundwater inflow.

Agricultural Indicators

Now I will switch gears a bit and present some draft indicators for agriculture and later forestry

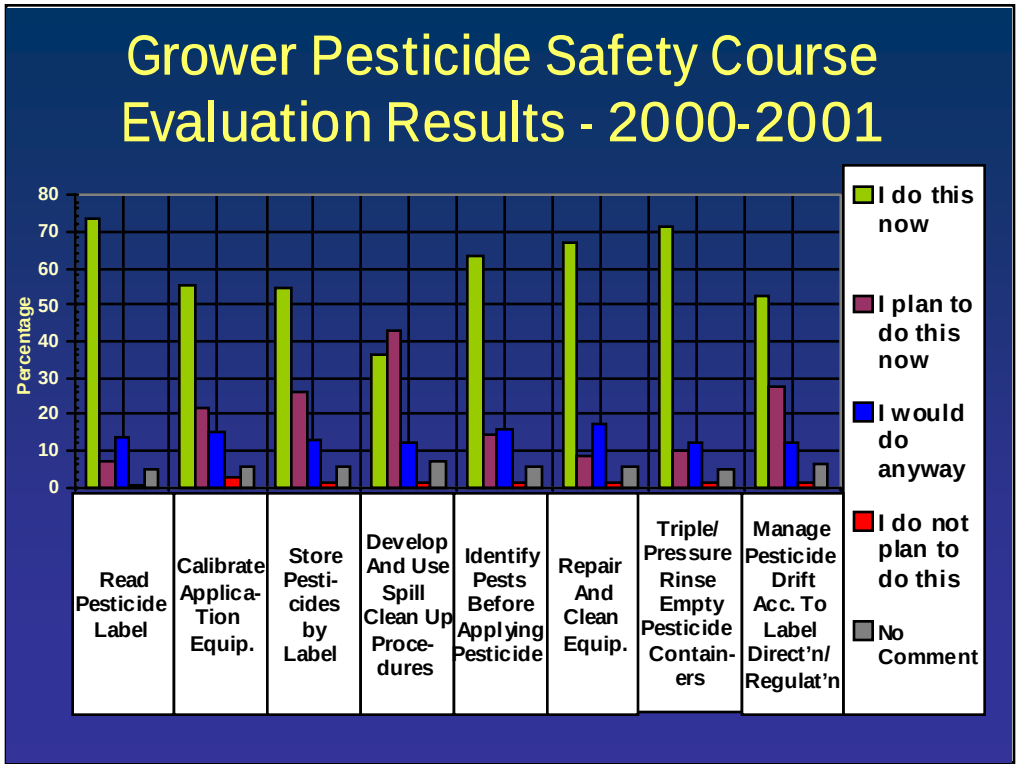
Integrated Pest Management

- This indicator reports the adoption of Integrated Pest Management (IPM) practices and the effects IPM has toward preventing surface and groundwater contamination in the Great Lakes Basin.

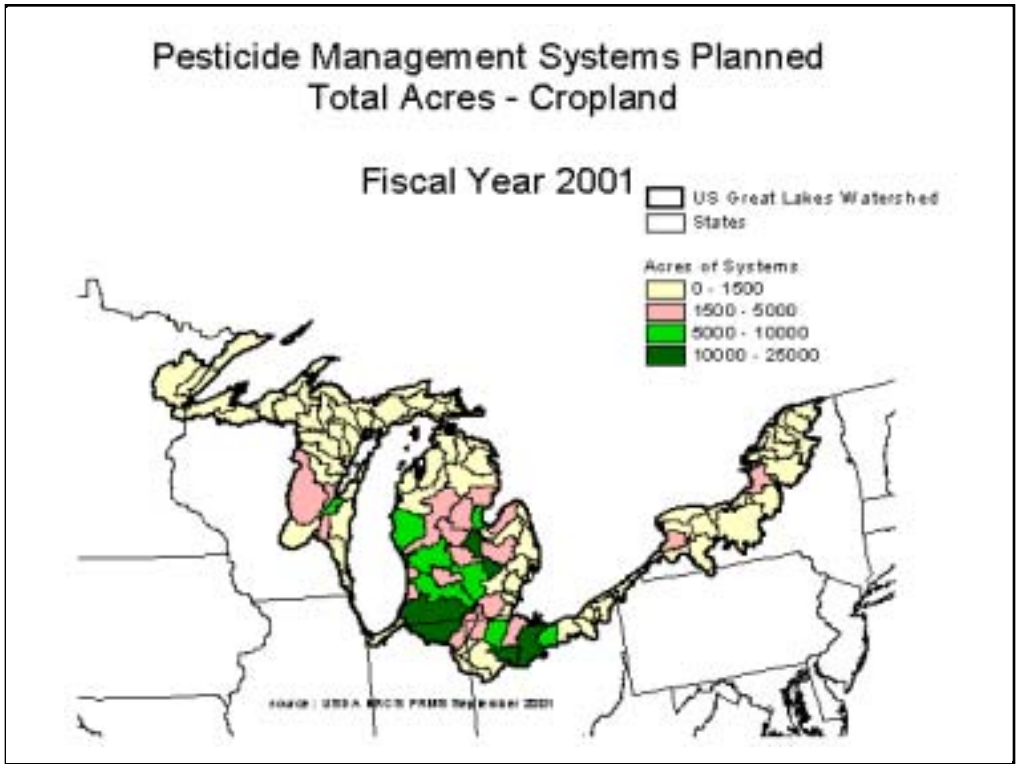
•The objective of this indicator is the sound use and management of soil, water air, plants and animal resources to prevent degradation.

•Integrated pest management is utilizing environmentally sensitive prevention, avoidance, monitoring and suppression strategies to manage weeds, insects, diseases, animals and other organisms (including invasive and non-invasive species) that directly or indirectly cause damage or annoyance.

•Pest management must minimize negative impacts of pest control on all identified resource concerns.



The Ontario Pesticides Education Program provides farmers with training and certification through a pesticide safety course. This chart shows the degree of compliance with various pesticide management techniques. As you can see, there is a very high % of people surveyed who "do this now", meaning employing sound pesticide management techniques. This is an encouraging sign.



Here is a different way of looking at the same information. Here we see US pesticide management systems planned for 2001, by county

The USDA Natural Resources Conservation Service reported that pest management practices were planned for over 200,000 acres of cropland in the US Great Lakes Basin for Fiscal Year 2001

The darker the color, the more plans are in place. There is a correspondence with areas of high base flow.

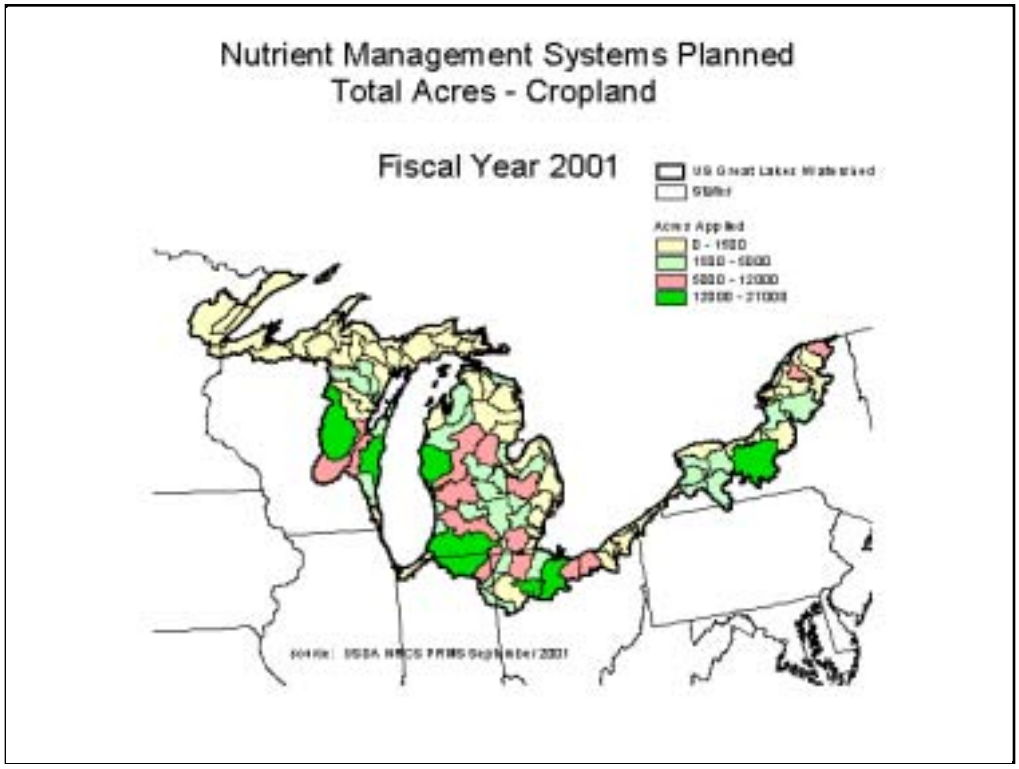
Nutrient Management Plans

- Reports the number of Nutrient Management Plans in place, and infers environmentally friendly practices, to prevent ground and surface water contamination.

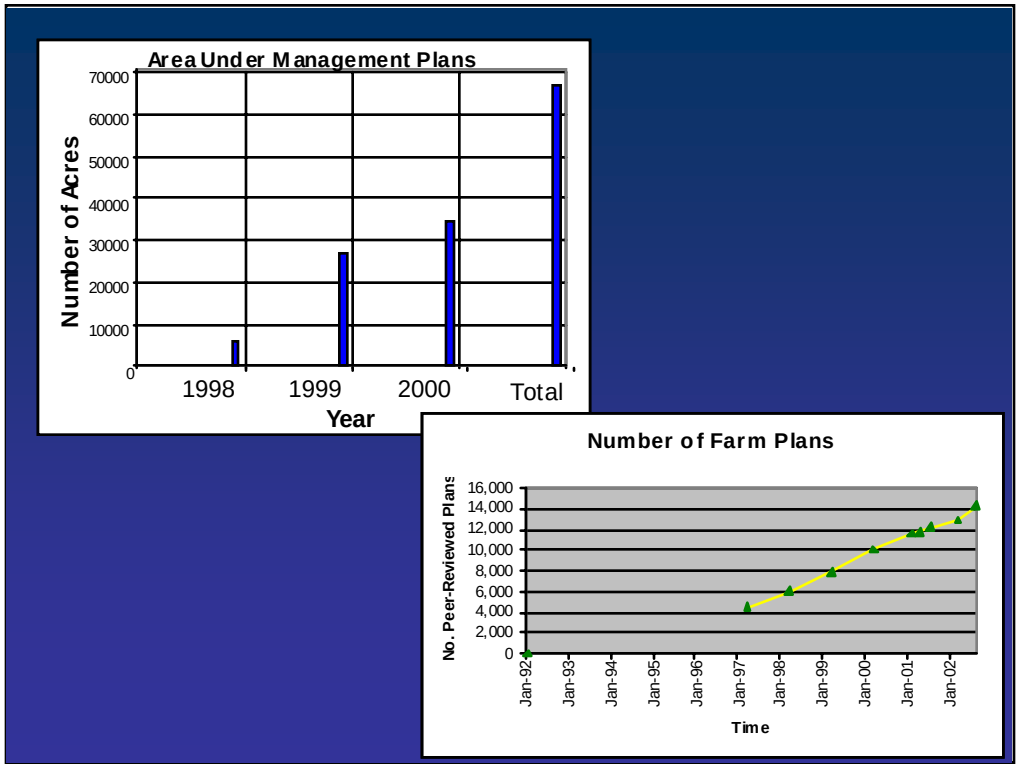
•The objective of Nutrient Management Planning is to mange the amount, form, placement and timing of applications of nutrients for uptake by crops as part of an environmental farm plan.

•It is expected that more farmers will embrace environmental planning over time.

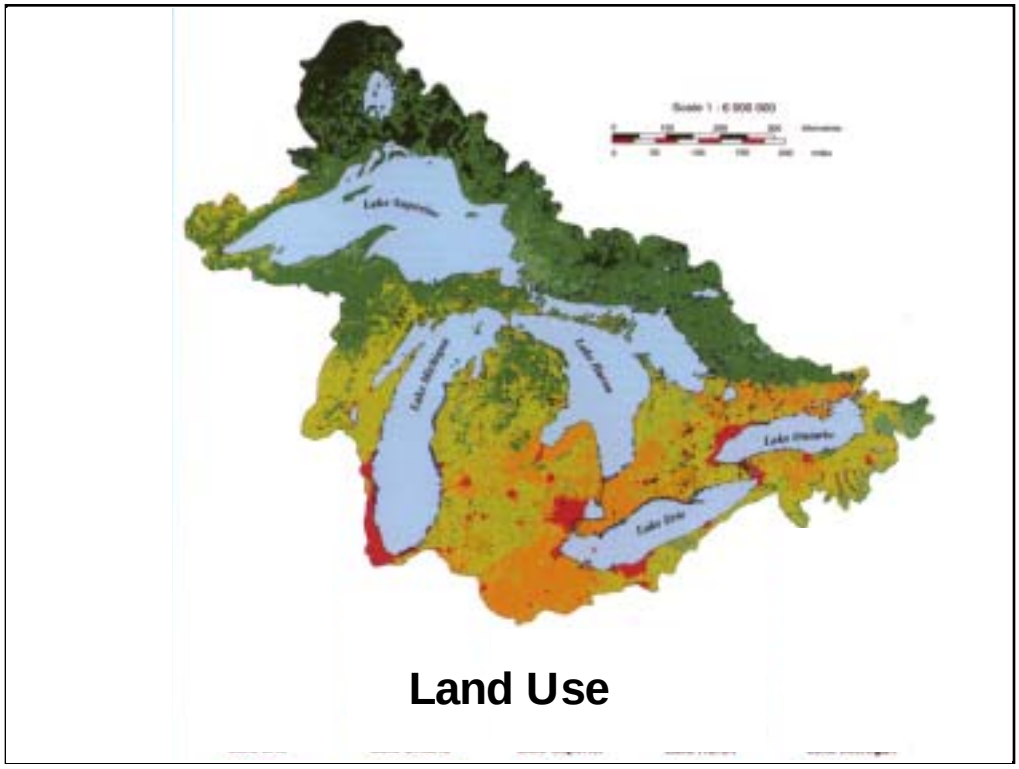
•This results in sustainable agriculture through non-polluting, energy efficient technology and best management practices for efficient and high quality food production.



Annual U.S. Nutrient Management Systems Planned for FY2001 in acres. Again there is a correspondence with areas of high base flow.



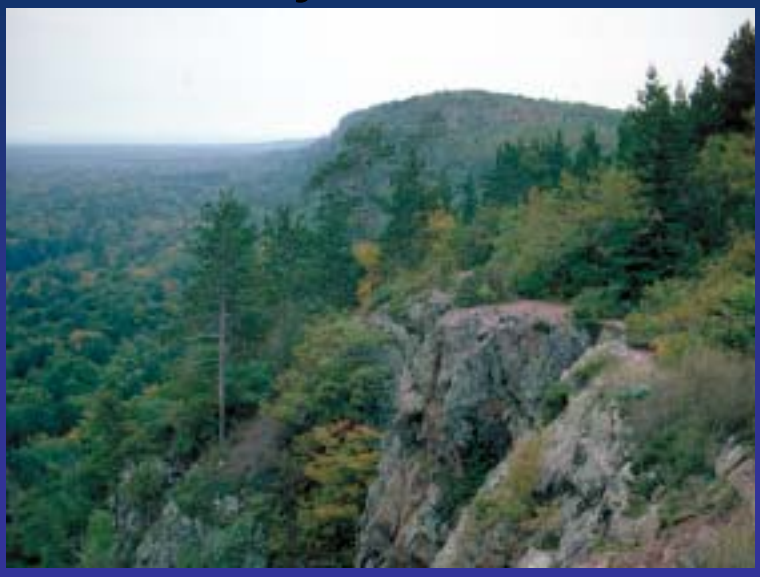
These graphs show the acreage under Nutrient Management Plans, and the total number of farm plans in Ontario. An encouraging upward trend for both.



Land Use

As I move into the forestry indicators, once again, a reminder of where the majority of Great Lakes forest resources are located in the basin..

Forestry Indicators



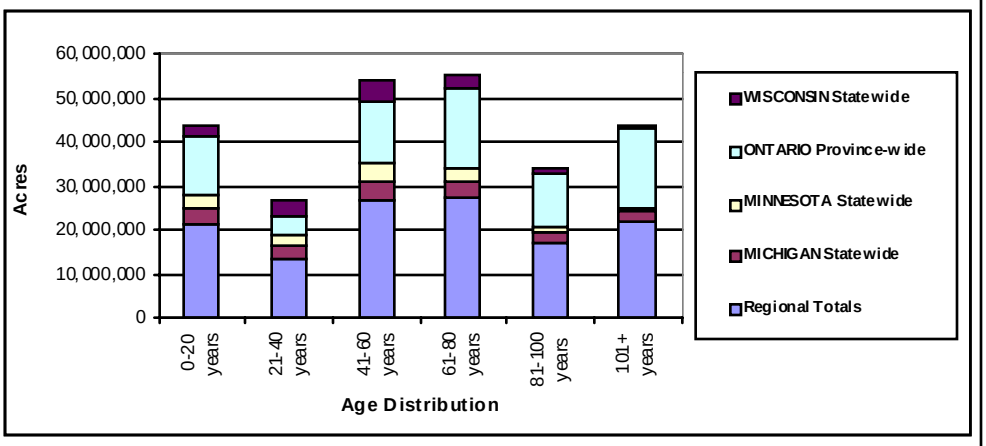
Next I will quickly review some proposed forestry indicators. These were developed by the Great Lakes Forest Alliance, which you heard about earlier this morning from their Executive Director Wendy Hinrichs Sanders. The indicators that are illustrated are highlighted in yellow.

I am only going to illustrate some of the indicators here. These were created from an existing GL Forestry Alliance report that was released in August 2001

1. Proportion of forest area in each cover type and age-class (or successional stage).
2. Abundance of and trends in rare, threatened and endangered forest-based species.
3. Amount of habitat for selected forest species.

Our first example deals with forest age structure and species mix.

Forest Age Distribution (stand age in acres) with Regional Totals

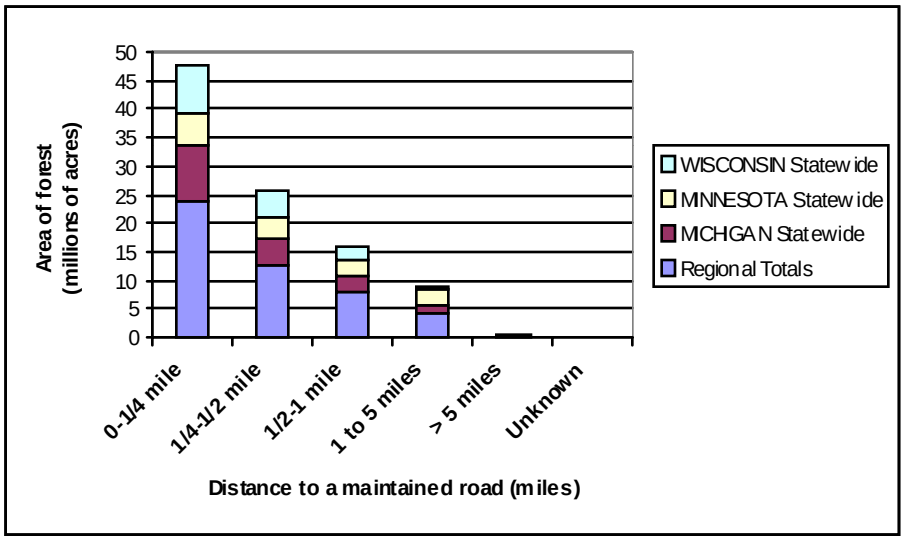


This is one example of several possible data displays. It shows the age distribution of forests in Ontario, Michigan Wisconsin and Minnesota

4. Trends in the area of forest land due to land use change, including deforestation and afforestation.
5. **Fragmentation of forest types**
6. Compliance with and effectiveness of water quality Best Management Practices

Our next example illustrates a problem faced by many habitat types including forests, namely fragmentation.

Fragmentation of Forests with Regional Totals



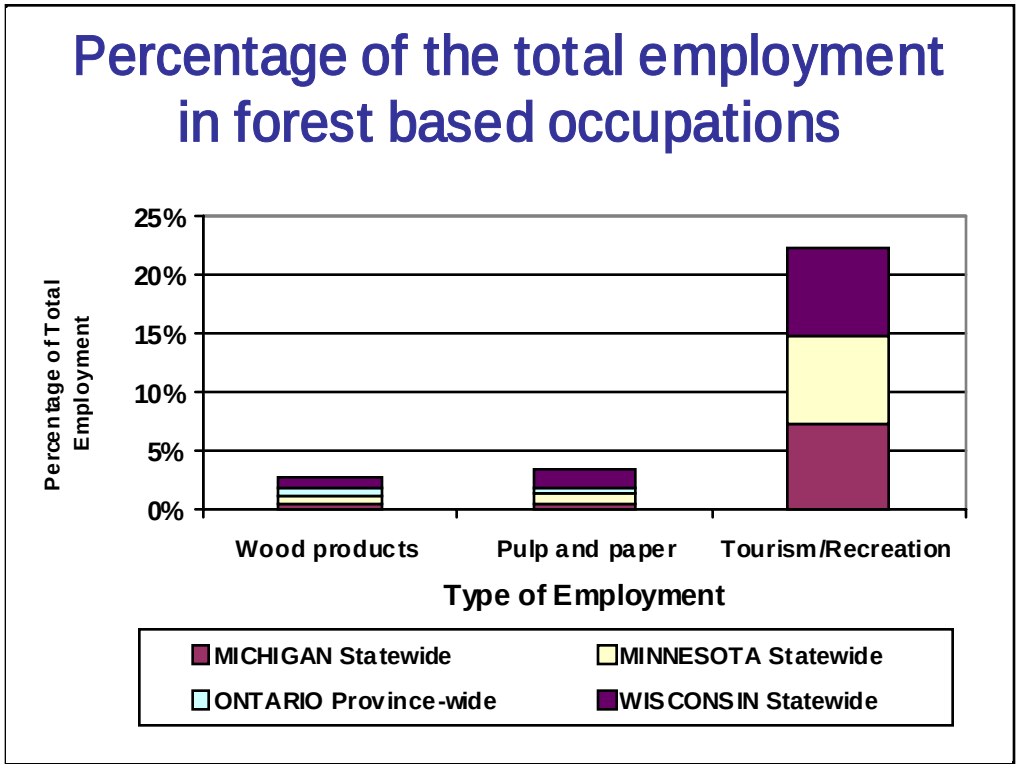
This graph illustrates the large area of forest in the northern part of the basin that is within 0.25 miles of a road, meaning a highly fragmented habitat.

7. Area and severity of occurrence of non-native (invasive species) species detrimental to forest condition.
8. Forest land ownership and utilization. (to be defined)
9. Ranges of uses of the forest and meanings for those uses

I do not have an illustration for any of these indicators, but these data do exist and can be provided.

10. Forest based employment by sector.
11. Representation of all publics in the public participation process.
12. Capacity to measure and monitor changes in the conservation and sustainable management of forests.

Finally, we look at forest based employment.



As you can see, wood products, pulp and paper and tourism together are very significant components of the northern landscape.

Well, that is a very quick tour of three subject areas and the indicators that are being proposed for them.

I urge those of you interested in these topics to attend the breakout sessions this afternoon.

And finally, some acknowledgments…

Thank you.

Acknowledgments

Groundwater:

Doug Alley, Bob Davic, Doug Dodge, Fred Fleischer, Norm Grannemann, Wendy Leger, Cheryl Martin, Donna Myers, Andrew Piggott, Harvey Shear, Sam Singer

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Forestry: Bill Meades; Great Lakes Forest Alliance